and falling from 66 to 44 miles over Merioneth and Cardigan, Wales. Its observed length of path was 55 miles and velocity 14 miles per second. It is remarkable that though few, if any, of the smaller class of shooting stars diverge from this radiant near δ Cassiopeiæ in the spring months it yet furnishes many fireballs. In the General Catalogue of Radiants, No. xv. p. 228, the radiants of five fireballs appearing in April and May give a mean centre at 20° + 57°, which is almost identical with that of the bolide of April 21 last. W. F. DENNING.

CHEMISTRY IN ITS RELATIONS TO ENGINEERING.[1]

THE engineer of fifty years ago can hardly be said to have received any special educational training; he forced himself to the front in virtue of his qualities and industry alone. But the youth who to-day intends to become an engineer feels it wise, if not necessary, to decide where he shall receive, not only his general, but also his engineering education. While he was at school he will have learnt much about the simpler and more general laws and facts of mechanics and natural science, both by description and by practical work in the laboratory and in the workshop; he will also have attained to some proficiency in mathematics, in one or more of the modern languages, in drawing and in other usual school subjects. When he passes on to his college career his knowledge of these subjects will undergo expansion in the class-room and especially in the laboratory and workshop. It is satisfactory to find that many of our leading schools for training engineers exist in connection with institutions in which pure and applied mathematics, natural science and modern languages are efficiently taught even in their higher stages. The engineering student is thus afforded the opportunity of following up the higher study of any one of these subjects, if his taste and energy lead him to wish him to do so. But even his ordinary course of instruction always includes the opportunity of obtaining lecture and laboratory instruction in chemistry.

Chemistry in Engineering Education.

It appears to be the general feeling of those who have had experience in teaching chemistry to engineering students that it is useless to attempt very much in the small amount of time which can be allotted to the subject in the regular curriculum; it is evidently felt, however, that a student who wishes to attain to any considerable proficiency in the subject should be encouraged to join certain additional courses which are included in the ordinary chemical curriculum.

Probably all that can be expected of the average engineering student is that he shall become generally conversant, during his college course, with chemical language, with chemical principles and laws, and with the chemical nature of the materials with which he has to deal; and that he should obtain such an insight into chemical analysis as to be able to confer with the trained chemist, and to understand the meaning of a general statement of the results of chemical analyses bearing on metals, alloys, fuel, lubricants, cements and other materials which are frequently used by the engineer.

It is beyond question that the engineer has too many calls upon his time and energy, both in his training and in his subsequent career, to allow of his becoming a chemist or a chemical analyst; but he should at least be sufficiently conversant with the science to enable him to appreciate the important bearings of chemistry on his varied requirements, and to enable him to avail himself intelligently of the results of chemical investigation and analysis. He should be able to watch and to appreciate any chemical inquiry and investigation, even if he is not qualified to suggest its methods of procedure or to carry it out himself.

It has been stated to me by a German manager of large English works, who has frequently occasion to call in the professional advice and assistance of both engineers and chemists, and who is himself well educated in both departments, that he has to lament in this country the "absence of useful engineering knowledge among chemists, and of useful chemical knowledge among engineers." Another informant states that Germany employs many more trained chemists working in conjunction with her engineers than England does.

Applications of Chemistry to Engineering.

In order to illustrate some of the advantages which engineers have derived from chemical coadjutors, one or two instances may be selected from different fields of engineering activity and enterprise.

In the matter of supplying the engineer with suitable constructive materials, the most striking case is that of the introduction of cheap steel of varying qualities in substitution for costly steel and other less suitable forms of iron.

The Bessemer process owed its original suggestion, as well as its salvation from failure, to the chemical knowledge which was supplied to those who were interested in the procedure. It further owed the extension of its application to all the commonest, cheapest and most abundant kinds of impure English cast iron to the further utilisation of chemical knowledge and suggestion.

At the present time the metallurgical chemist and the chemical metallurgist are engaged in furnishing metals and alloys, new to commerce, which can rank in importance with cheap steel, only in a somewhat minor degree; and the engineer in every department of his activity is now continually having placed at his disposal alloys which are more suitable for his various designs than any which he has hitherto employed.

It is scarcely necessary to point out the absolute necessity of chemical knowledge and chemical advice to the gas engineer. In the matter of water supply, also, both the engineer and the chemist find their respective but closely connected spheres of duty.

There is another direction in which the constant relation of chemistry to engineering, and in which the association of the chemist with the engineer must be maintained, if success is to be secured and expensive failures are to be avoided.

In no application of chemical and engineering principles is the co-operation of chemist and engineer more necessary for the attainment of success than in securing the suitable purification of our town sewage. Such co-operation has enabled London, Manchester and other large centres of population in recent years to carry out on an experimental scale most important trials of the natural or bacterial treatment of sewage, and has led to reports on this method being published which will probably become classical. This experimental work has led to considerable and valuable development and improvement of the bacterial method. There is now no doubt that this process can inexpensively dispose of a large proportion of the putrescible sediment or sewage-sludge, and can render the effluent, not only non-putrescible and suitable for maintaining the life of fish, but even pure if necessary. The process is therefore destined to effect great reforms in our sewage-disposal problem and considerable improvements in the condition of our watercourses.

[1] Abstract of the "James Forrest" lecture delivered at the Institution of Civil Engineers on April 25 by Prof. Frank Clowes.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Rede Lecturer for the present year is Dr. F. W. Maitland, Downing professor of law. Dr. Haddon, F.R.S., gives this term a course of lectures on studies in Papuan ethnology and the races of Oceania, on Mondays and Fridays at 2.30 p.m.

The Medical School Buildings Syndicate recommend the acceptance of tenders for the erection of the Downing Street wing and the Humphry Museum, amounting to more than 26,000*l.*

The Frank Smart studentship in botany at Caius College, of the annual value of 100*l.*, will be vacant at Michaelmas. Candidates must have taken honours in Part i. of the Natural Sciences Tripos. Further information may be had from the senior tutor of the College.

A meeting was held in St. John's College on April 27 for the purpose of procuring a portrait of Prof. Liveing, F.R.S., as a memorial of his lifelong services to the University. The meeting was largely attended by members of the Senate, and a warm tribute was paid to the professor, who began his teaching of chemistry fifty years ago, and who during that time has in many ways, public and private, benefited the University, town, and county of Cambridge. A strong committee was formed to carry out the purpose of the meeting.

Prof. Newton announces that there are vacancies for workers at the University tables in the Plymouth and the Naples zoological stations. Applications are to be sent to him by May 23.

Twenty-one candidates have passed the half-yearly examination in sanitary science for the diploma in Public Health, held in April.

Dr. J. N. Langley, F.R.S., is re-appointed deputy-professor of physiology until Michaelmas 1903, in the place of Sir M. Foster, M.P.

MR. R. T. SMITH has been appointed principal of the Northern Polytechnic Institute. He organised and equipped the South African College, Capetown, and acted as professor of mathematics and physics in the College for several years; and, more recently, was lecturer in mathematics and physics in the Goldsmiths' Institute, New Cross.

THE Secretary of State for War has appointed a committee to consider the education of candidates for commissions in the Army and the system of training at Woolwich and Sandhurst, and to report whether any changes are desirable in the present methods of entrance into the Army. The following will form the committee:—The Right Hon. A. Akers-Douglas, M.P. (chairman); the Rev. Dr. Warre, headmaster of Eton; Mr. F. W. Walker, high master of St. Paul's School, Hammersmith; Colonel Jelf, C.M.G., Royal Engineers; Lieutenant-Colonel Hammersley, Lancashire Fusiliers; Captain Lee, M.P., late professor of strategy and tactics, Royal Military College, Canada; and Captain W. E. Cairnes, Royal Irish Fusiliers (secretary).

ADVOCATES of improvements in geometrical teaching will be glad to know that the Civil Service Commission has lately introduced a change of importance to all who are concerned with Civil Service examinations. Before this year an instruction at the head of examination papers in geometry stated that "Proofs other than Euclid's must not violate Euclid's sequence of propositions." Upon recent papers, however, this has been superseded by the note that "Correct demonstrations, whether those of Euclid or not, will be accepted." It thus becomes possible for teachers preparing pupils for the Civil Service to be independent of Euclid's sequence or proofs. Recent questions also encourage teaching of a less abstract character than that usually associated with Euclid's geometry. We understand that the Board of Education will accept alternative proofs of propositions in future examinations in geometry.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, April 26.—Dr. R. T. Glazebrook, foreign secretary, in the chair.—A paper on the thermodynamical correction of the gas thermometer was read by Prof. H. L. Callendar. This paper commences by giving a short historical sketch of the thermodynamic correction of the gas thermometer, describing some of the solutions to Thomson's fundamental equation for the Joule-Thomson plug experiment. The assumptions made in the solutions have sometimes been erroneous and wrong corrections have been obtained. From 1885 to 1888 Chappuis made a series of careful comparisons between various gas thermometers and a very delicate mercury thermometer, and drew up a table of differences between the hydrogen and the nitrogen thermometer. The author has taken the observations of Chappuis and calculated a new table of differences. The index "n" in the modified Joule-Thomson equation is not constant. For steam it is about 3·5 and for carbonic acid about 2. The thermodynamic correction is very small, especially in the case of hydrogen and helium, and is very much less than the correction for the expansion of the thermometer bulb. Prof. Herschell asked whether the co-volume came into the correction. Dr. Harker looked forward to the experiments which Prof. Callendar proposes to make with a constant pressure thermometer. The chairman expressed his interest in the extreme delicacy of the observations of Chappuis.—A paper on the production of a bright-line spectrum by anomalous dispersion and its application, the "flash-spectrum," by R. W. Wood, was read and experimentally illustrated by Mr. Watson. It has been suggested by W. H. Julius that the "flash-spectrum seen immediately at totality may be due to photosphere light abnormally refracted in the atmosphere of metallic vapours surrounding the sun. The light which will be thus abnormally refracted will be of wave-lengths almost identical with the wave-lengths which the metallic vapours are themselves capable of radiating. The sun is supposed to be surrounded by an atmosphere of metallic vapours, the refractive index of which decreases with increasing distance from the surface. In this atmosphere the rays of light coming from the photosphere move in curved paths. The refractive index is, however, very small, except for wave-lengths very near those absorbed by the vapour, consequently the light which resembles that emitted by the vapours, is most strongly refracted, and therefore curves sufficiently to reach us after the photosphere has been hidden by the moon. The flash-spectrum of sodium was shown by focussing the light of an arc lamp on a horizontal slit in front of a flat metal plate supported so that the plane in which its under-surface lay coincided with the plane of the slit. At a distance of about two metres a direct vision spectroscope was arranged to give a vertical spectrum and placed at such a height that the prism barely caught the rays coming from the slit and grazing the plate. On looking into the spectroscope a bright continuous spectrum is seen. A Bunsen burner was then placed underneath the metal plate and fed with sodium. This produced a layer of sodium vapour of varying refractive index. On raising or lowering the spectroscope bright sodium lines are seen due to anomalous dispersion. By arranging screens these lines can be obtained so that, on cutting out the arc lamp, the flash-spectrum vanishes. Prof. Herschel expressed his interest in the experiments and their application to the case of the flash-spectrum seen at totality.

PARIS.

Academy of Sciences, April 22.—M. Fouqué in the chair.—On the residues and periods of double integrals of rational functions, by M. Émile Picard.—On an apparatus designed to move the photographic plate which received the image furnished by a siderostat, by M. G. Lippman. In an image given by a siderostat only one point is really fixed, the other points appearing to move round this with a variable velocity. It is shown that a suitable motion can be given to the photographic plate capable of overcoming this defect by means of a gear driven by the clockwork of the siderostat.—On the existence of nitrides, argonides, arsenides and iodides in crystalline rocks, by M. Armand Gautier. The finely powdered granites and basalts were decomposed by heating at 100° with phosphoric acid. Determinations are given of the amount of nitrogen, arsenic and iodine in various rocks.—Comparison of the work done by a muscle in sustaining and lifting a charge, by M. A. Chauveau.—On the propagation of discontinuities in a viscous fluid; extension of the law of Hugoniot, by M. P. Duhem.—On a question relating to a displacement of a figure of invariable size, by M. R. Bricard.—On entire functions of several variables and their modes of growth, by M. Émile Borel.—Some isotherms of ether between 100° and 206°, by M. Edouard Mack. The pressure of the ether vapour was balanced by a piston floating on a very viscous liquid, and the volume of the ether, which was completely surrounded by a mercury bath, was deduced from the motion of the piston.—Cryoscopic researches, by M. Paul Chroustchoff. An account of some of the precautions necessary in applying the platinum thermometer to the measurement of the lowering of the freezing-point of dilute solutions.—On a new system of ammeters and voltmeters independent of the intensity of their permanent magnets, by M. Pierre Weiss. In an instrument of the d'Arsonval type a decrease in the strength of the permanent magnet causes a decrease in the sensibility of the instrument; in instruments having a movable magnetic needle controlled by a permanent magnet the opposite is the case. If, in an instrument of the moving coil type, the coil carries a small piece of soft iron, these two effects may be made self-compensating. It was found possible to construct a galvanometer of this type in which the sensibility was practically invariable.—On the influence of self-induction upon spark spectra, by Mr. G. A. Hemsalech. Three photographs are given showing the progressive changes produced in the spark spectra of cobalt, lead and magnesium by an alteration in the self-induction of the spark circuit.—Periodic oscillations productions by the superposition of an alternating current on a continuous current in an electric arc, by M. E. Kœnig.—On an apparatus which imitates the effect of luminous fountains, by M. G. Trouvé.—On barium hydride, by M. Guntz. Barium hydride, the existence of which was first indicated by Winkler, has been obtained in a pure state and found to have the composition BaH_2. This compound is of remarkable stability; it can be slowly sublimed in a current of hydrogen at 1400° C. without decomposition. Heated in a current of nitrogen, barium nitride is formed.—The estimation of nitric acid in waters by means of stannous chloride, by M. H. Henriet. The fact discovered by Divers and Haga that nitrates react with stannous